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(54) Steep gradient static characteristics electrical transformer

(57) In an electrical transformer the primary and secondary coils 2, 3 each comprise a conductive band substantially as wide as the coil. Each primary coil is mounted on the same magnetic core column as one or more secondary coils so that the primary and secondary coils are coaxial and face one another with a gap between them. At high currents the current through the coils tends to shift to the outer (non-adjacent) edges of the conductor bands, and the gap encourages dispersed flux 6 which does not link both coils. These factors increase the slope of the output characteristic such that the short circuit current can be only twice the operating current.

FIG. I

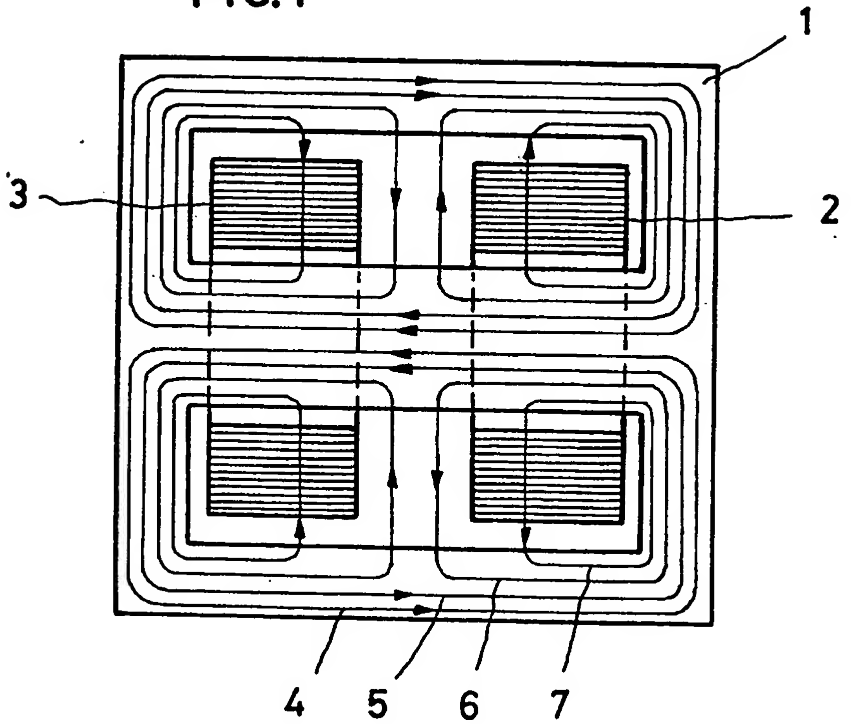

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FIG.1

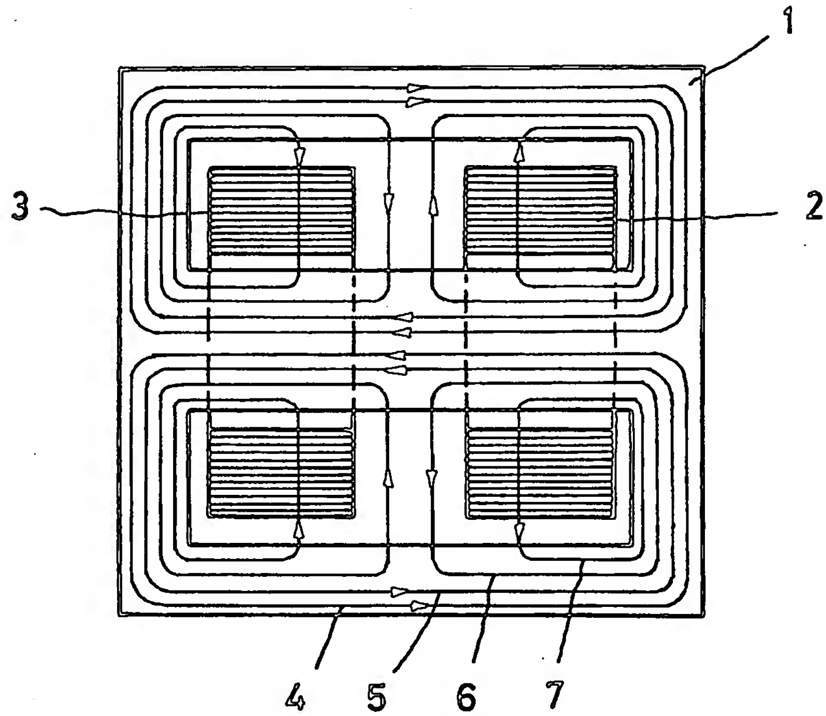

FIG.2

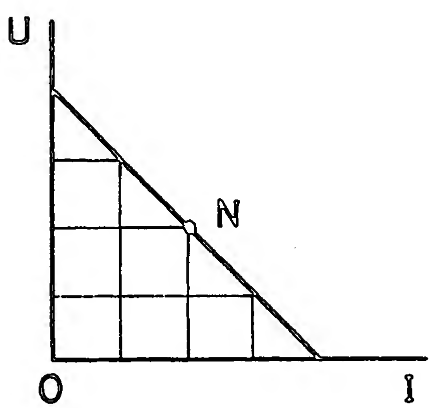

FIG.3

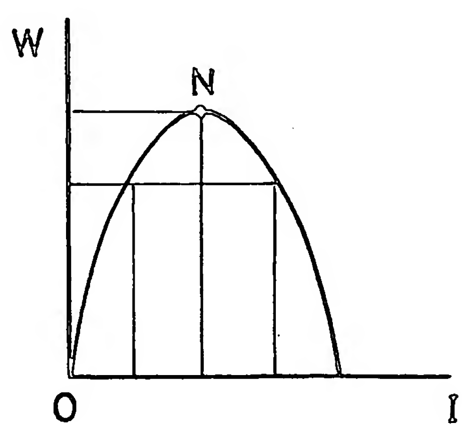

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FIG.4

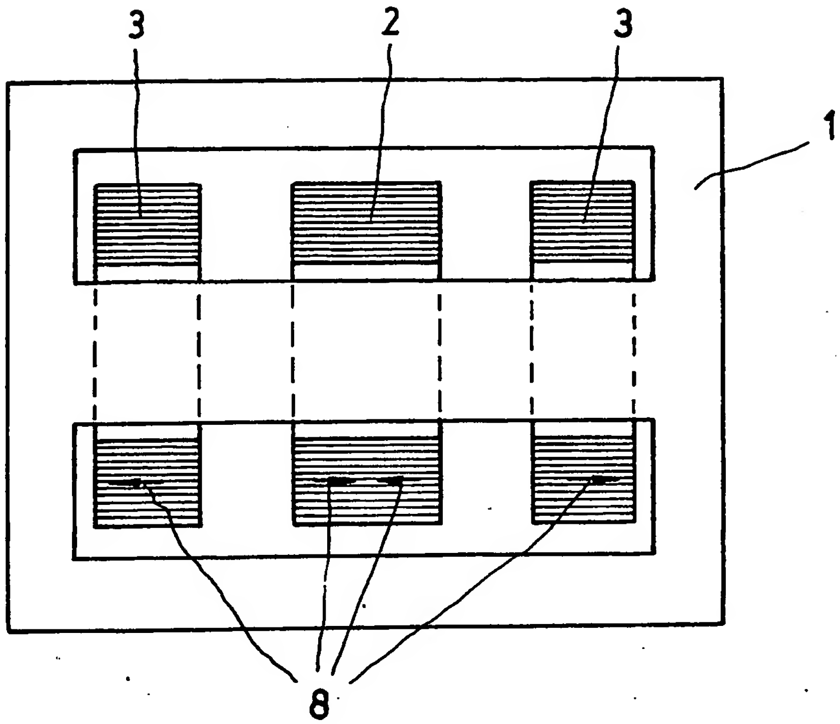
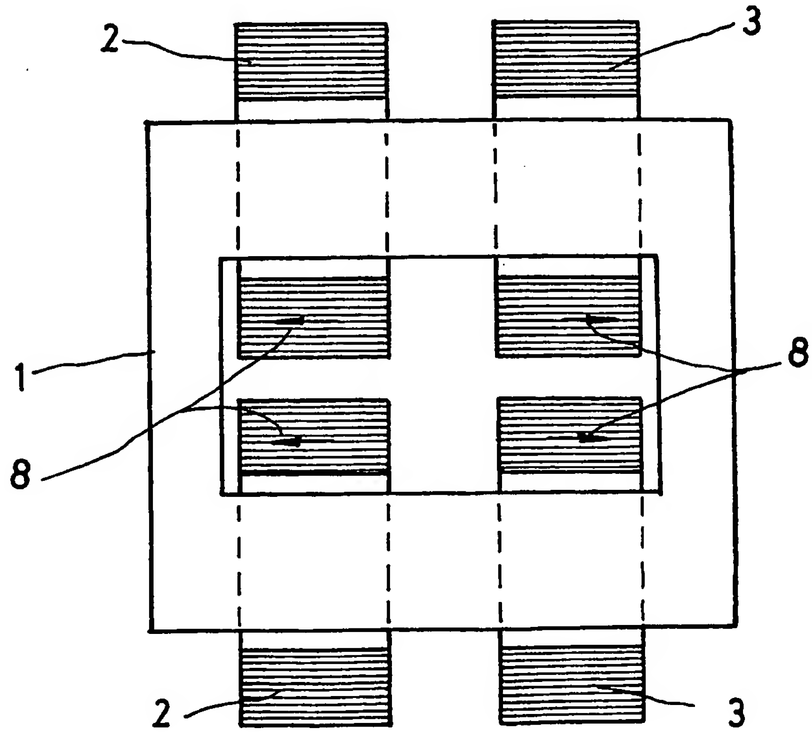


FIG.5



SPECIFICATION

Steep gradient static characteristics electrical transformers

The present invention relates to improvements in transformer constructions, of the type having steep gradient characteristics and free from short-circuiting.

The great majority of all electrical power transformers used around the world are for transforming an input power expressed in volt-amperes into an output power which, while maintaining the volts by amps product, has reach of these factors inversely modified. Almost always, the fundamental condition is of an economic nature and the aim is that the transformer efficiency should approach unit.

Nevertheless, there are special applications for which the efficiency ceases to be of prime importance and, on the other hand, the transformer is required to have a static characteristic which could be classed as anomalous, such as is for example, that its short-circuit current should be only twice the rated current. Such can be the case with transformers for welding or for supplying traction motors, where a high degree of immunity from short-circuiting is wanted, without the need to resorting to external protection equipment.

The invention is defined in the appended claims to which reference should now be made.

It is known that one of the greatest enemies to the efficiency of any transformer is the so-called disperse flux, namely, magnetic flux not common to the primary and secondary windings. Therefore, on disposing the coils so that for high loads the flux dispersion is favoured, and at the same time the primary and secondary winding currents tend to shift, an increase in the apparent ohmic resistance of the windings is obtained.

It is also well known that the electrical fields of the primary and secondary winding coils produce a mutual repulsion tending to separate the coils. It is also known that to obtain flat characteristic transformers, namely, ones in which the secondary voltage is practically constant with an increase in the load, it is necessary to superimpose and overlap the coils so that the opposed magnetomotive forces should combine prior to becoming flux in the core.

The invention will be described in more detail, by way of example, with reference to the drawings, in which:—

Figure 1 is a schematic overall sectional illustration of one transformer embodying the invention.

Figure 2 is an approximate plot of the static characteristic of the transformer.

Figure 3 is a plot of the power in the transformer secondary winding.

Figures 4 and 5 are schematic illustrations of further transformers embodying the invention.

In Figure 1 there is to be seen a magnetic core 1 which, as a non-limitative example, is shown as a shell type. The primary coil 2 and secondary coil 3 are both located on the centre arm of said core. Each of said coils is constituted by a helically wound conductor band or tape, and the coils are substantially the same width as the bands from which they are formed.

Lines 4 and 5 show the circulation of the common flux through the core 1, interlinking both coils. Line 6 shows a disperse flux circuit affecting coil 2 only and jumping across the air from the core centre column to the outer columns.

In an arrangement like the one described, the mutual repulsion between the electrical fields of the coils, as has already been said above, tends to separate the coils and since it cannot physically move them because they are fixed in place, what it really produces is a shift of the currents flowing through both coils towards the outer edges thereof, current shifts which are only possible thanks to the laminar form of the conductors. The result of this phenomenon is that the current density ceases to be constant; it is reduced at the inner edges of the tape and increases at the outer edges, whereby the apparent ohmic resistance of the winding increases. In fact, under these conditions, it is as though the conductor width had been reduced and as though the coils had separated. This greater apparent separation of the coils increases the flux dispersion area, shown in Figure 1 by the lines 7 of disperse flux.

Thus the static characteristic of the transformer takes on approximately the form shown in Figure 2, with a strongly decreasing secondary voltage *vs* the output current. Assuming that the rated operating point is N, the operating voltage is half the open-circuit voltage and the short-circuit current is twice the operating current.

In Figure 3, illustrating the power in the transformer secondary, it is shown that this power is maximum at the rated operating point N and becomes zero both under open-circuit and in short-circuit.

Figure 4 illustrates an embodiment in which on one single core column 1 there is one primary coil 2 and two secondary coils 3. It is also possible to have two primary coils and one secondary.

Finally, in Figure 5, there are to be seen two pairs of primary coils 2, each facing a corresponding secondary coil 3, each primary/secondary pair being mounted on two separate columns of the core 1. The arrows 8 show the current shifts.

CLAIMS

1. A transformer, wherein each of the coils of both the primary winding and of the secondary winding is constituted by a helically wound conductor band, the coil being substantially the same width as the band from which it is formed, and each coil of one of the windings being mounted on one same magnetic core column as one or more coils of the other winding, so that the coils of the different windings coaxially face one another to produce current shifts due to the repulsion between both electrical fields, and wherein there is a gap between such coils to favour the dispersion of the magnetic flux, whereby there is attained an apparent increase of the winding resistance and an increase of the dispersion area as the current increases.

2. A transformer substantially as herein described with reference to the drawings.

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